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# *THE BRIEF*

## *Winter 2011-2012*

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### *From the Editor*



(left to right) Tom Hall – CWSU Forecaster, Roger Smith – CWSU Forecaster,  
Neil Haley – CWSU Forecaster and Jim Reynolds – CWSU Meteorologist-in-Charge

## ***Air Traffic Manager Transition***

*By Larry Braaten, Operational Manager*

I will be returning to my Operation Manager role shortly after the first of the year. My experience as the Acting Air Traffic Manager was interesting and very fulfilling. Overall this is a great and fairly easy Facility to manage. Probably the biggest challenge I faced during my tenure was balancing the needs of the Agency (or the individual) against our own Facility's needs. As a level 10 Facility, there are many other opportunities out there at higher level Facilities. The potential growth for the individual and assistance we can provide other Facilities, still makes for some challenging decisions though.

There is a tremendous talent pool here. We are often recognized nationally for the work we accomplish and it should instill a sense of pride in all of us. We are also known for our ability to accomplish just about any task and do it well in addition.

Please join me in welcoming back Terry Locke. Terry gained some valuable experience in the ATSAP arena on the ERC and most recently as the Manager, Tactical Operations. Terry has been gone a while and we all need to help make this a smooth transition given the changes that have taken place here over the last couple of years.

Introduce yourself to Terry if you haven't met him, just say welcome back if you have, and don't forget about me. Thanks for everything.



## ***Arrivals and Departures***

Trey Madrid - gone to ATSCC 11/20/2011

Kay Wiley - retired 11/29/2011



## ***Newly Minted Certified Professional Controllers***



Derek Bray (East) 11/11/11

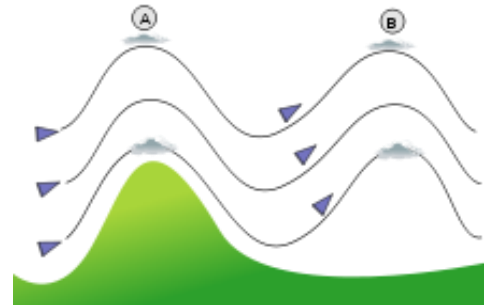


# Mountain Wave

By TMU Crews 2,3 and 4

Albuquerque Center contains a lot of mountainous terrain and routinely sees aircraft filed on mountain wave avoidance routes. What does this mean to me? How does this affect air traffic?

Mountain wave occurs when air passes over a mountain range or ridge. As the air climbs up the mountain, it creates an updraft which turns into a downdraft as the air passes over crest. From this point, and for miles downwind, there can be a continuing series of up and downdrafts. This up-and-down action puts the “wave” in mountain wave. Satellite photos of the Rockies have shown mountain waves extending hundreds of miles downwind of the range.



Wave formation varies depending on the time of day or time of year. In the summer, mountain wave forms most often in the early morning and late afternoon. Winter is the best time for formation as the jet stream moves further south and increases in strength. Cooler surface temperatures combined with more stable air make conditions ripe for mountain wave formation.



Wave action can produce light turbulence along with altitude changes and airspeed fluctuations. But with sufficient amplitude, wave action can create significant altitude and airspeed fluctuations accompanied by severe turbulence.

The U.S. Aeronautical Information Manual states, “Your first experience of flying over mountainous terrain, particularly if most of your flight time has been over the flatlands of the Midwest, could be a never-to-be-forgotten nightmare if you are not aware of the potential hazards awaiting...”

Mountain wave can cause more than just discomfort for passengers. The most severe cases of mountain wave with its associated turbulence can be injurious to passengers and flight crew, cause loss of flight control and possibly damage the aircraft.

Airline weather forecasters publish mountain wave predictions to aid dispatchers in filing avoidance routes that take aircraft around the areas of forecast mountain wave. Aircrews may use certain practices when coming close to the area, such as approaching at a 45 degree angle, avoiding ragged lenticular clouds and avoiding the area where the rotor occurs (downwind and below the wave, typically the most turbulent area). If this is not possible, they may change altitudes to avoid the most likely layers of turbulence.

Aircraft on mountain wave avoidance routes generally will not accept route changes or short cuts. This complicates busy spacing times and can thwart TMU plans to balance volume or comply with national playbook routes. Whenever possible, leave aircraft on their filed routes, since well-meaning shortcuts can put aircraft right back into the wave or turbulence.

Sometimes it is just not possible to avoid route changes. They are a necessary part of moving aircraft through the NAS. So what can we do? We might be able to wait until the aircraft are past the mountain wave area or issue an intermediate route that will miss the turbulent area and join the new route downstream.

Although forecast tools get better each year, maintaining awareness of the mountain wave activity and working with the pilots is still the best way to help ensure that aircraft can safely avoid the areas.

Sources:

Pilotfriend.com, Flying In Mountains, Mountain Wave

Wikipedia.com, Lee Wave and Wave Cloud

Flymsc.org, The Mountain Wave

Skybrary.aero, Mountain Waves

## ***National Weather Service Southwest Aviation Weather Safety Workshop Was a Great Success***

*By Jim Reynolds, CWSU Meteorologist-in-Charge*

On October 25<sup>th</sup> and 26<sup>th</sup>, the Albuquerque Weather Forecast Office, the ZAB CWSU and the Phoenix Weather Forecast Office hosted the fourth Southwest Aviation Weather Safety (SAWS) workshop at the Albuquerque Marriott Hotel. Approximately 92 pilots, air traffic controllers, meteorologists and weather briefers from across the country attended the two-day event that was held to promote aviation weather safety and productivity through improved weather awareness and forecasting services. Day one of the workshop concluded with a tour of Albuquerque Center and the CWSU with 48 people participating. After the tour, 40 people met at the Macaroni Grill directly across from the Marriott for a social dinner.



SAWS IV workshop planning group: back row (left to right) CWSU Albuquerque Forecaster Roger Smith, WFO Albuquerque Co-Aviation Focal Point Ken Widelski, CWSU Albuquerque Meteorologist in Charge Jim Reynolds and WFO Albuquerque Co-Aviation Focal Point David Craft. Front row (left to right) WFO Phoenix Aviation Focal Point Hector Vasquez, WFO Albuquerque Meteorological Intern Amanda Martin and WFO Phoenix Assistant Aviation Focal Point Jessica Nolte.

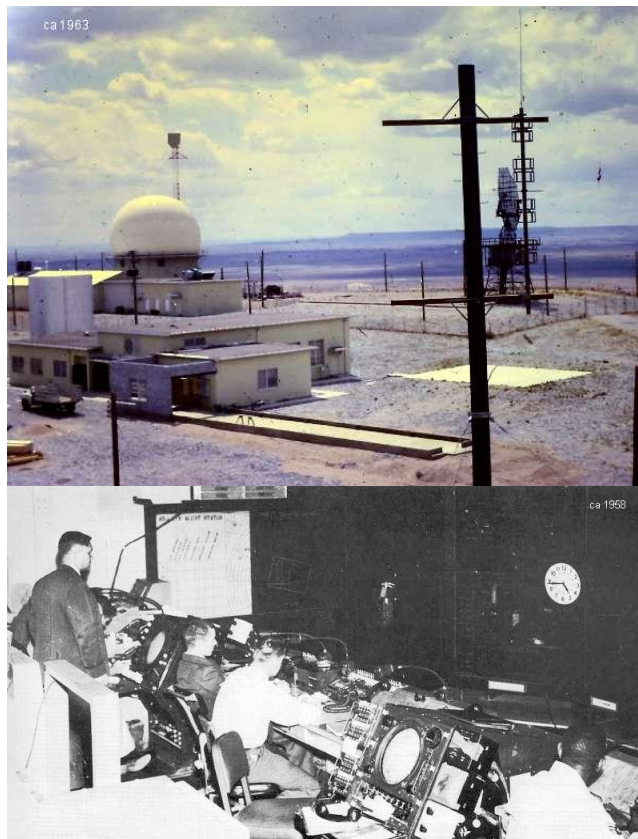
Some of the more recognized attendees at the workshop included: the U.S. Air Force, Southwest Airlines, NetJets, Sunshine Aviation Safety Studies and Lockheed Martin's Prescott Flight Service hub. **Joyce Woods**, President of the New Mexico Pilot's Association emailed the workshop planning group shortly after the event and exclaimed "well, the whole 'Aviator Day' was excellent!" SAWS V is currently planned to be held sometime in 2013 and will be hosted by both the Weather Forecast Office in Oxnard, California and the ZLA CWSU.

## Sister Facility Focus – West Mesa Radar Site

By Jim Reynolds, CWSU Meteorologist-in-Charge (information and pictures excerpted from [www.radomes.org](http://www.radomes.org))

The controlling of air traffic here at ZAB is the main focus of a large majority of individuals, and because of this, it is easy to forget that the FAA's mission inherent to this building cannot be accomplished without a lot of support from others outside of the building. Specifically, it would not be possible for the controllers to do their jobs without the radar data that is gathered from our remote sites. Of course, the integrity and timeliness of the radar data received at ZAB could not be met without the hard work of the individuals at these sites. This brings us to the point of this article, which is to raise awareness of the "Sister Facilities" that support ZAB.

In this article, we will focus on the West Mesa radar site. The West Mesa facility actually has a rich history that extends back to the early 1950's. Originally, the West Mesa site became operational in 1956 as the home of the Air Force's 687<sup>th</sup> Aircraft Control & Warning Squadron that used AN/FPS-7 search and AN/FPS-14 height finders



(above top) West Mesa radar facility circa 1963. (above bottom) – controllers working at the West Mesa radar circa 1958.



The West Mesa radar facility today. (photo courtesy of Amber Reynolds)

to provide radar coverage for the Albuquerque - Los Alamos region. By 1960, the West Mesa facility was also handling air traffic control functions for the FAA. In 1961, the site hosted an AN/FPS-20 search radar. By 1966, the 687<sup>th</sup> Squadron was operating an AN/FPS-91A set. The Air Force deactivated this squadron in September, 1968. Since the early 1990's, the West Mesa facility has been operating both primary and secondary (mode C transponder) radars. The facility is slated to receive a Critical Air

Route Surveillance Radar upgrade in April, 2013.





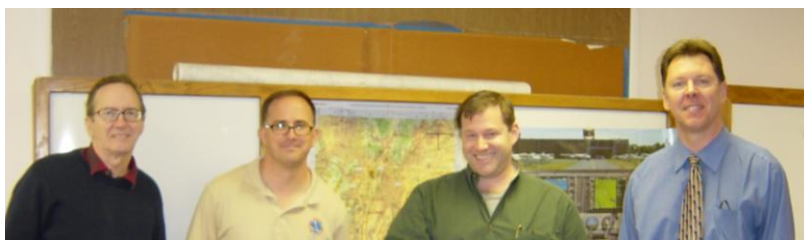
## ***ZAB CWSU and El Paso, TX National Weather Service Staff Reach Out to the Alamogordo, NM Airport***

*By Jim Reynolds, CWSU Meteorologist-in-Charge*

On Wednesday, October 19 staff from the CWSU joined forces with the El Paso Weather Forecast Office (WFO) to conduct aviation outreach at the Alamogordo-White Sands Regional Airport by meeting with

Airport Coordinator Parker Bradley. The meeting was especially significant because it marked the first

time staff from the CWSU teamed up with staff from another WFO outside of the WFO Albuquerque Forecast Area but still within the ZAB airspace to conduct aviation outreach.



(right to left) CWSU Forecaster Tom Hall, WFO El Paso Aviation Focal Point Lance Tripoli, Alamogordo Airport Coordinator Parker Bradley and CWSU Albuquerque Meteorologist in Charge Jim Reynolds



The Alamogordo Airport terminal building

The meeting began with an explanation of Alamogordo Airport operations and local airspace considerations. Mr.

Bradley described the impacts that neighboring White Sands Missile Range, Holloman Air Force Base and Fort Bliss have on the airport. Mr. Parker was quick to point out that pilots must stay within a narrow 10 mile-wide corridor when flying between Alamogordo and El Paso. In the current airspace configuration, pilots flying from Alamogordo to Las Cruces must negotiate the thin corridor southward to

within a few miles of the Texas border before reaching the southern end of the

Holloman airspace and then turning west toward Deming. The current routing requirements can add 30 to 60 minutes of flying time between the two cities each way without a direct shortcut. Mr. Bradley also informed the group that the Alamogordo Airport does not see any transient traffic from Holloman Air Force Base because the airport does not meet the equipment requirements of the military. Because of this, the Roswell International Air Center serves as the secondary airport for Holloman Air Force Base diversions.

Lastly, Mr. Bradley took the group on a tour of the airport grounds. This began with a viewing of the inside of the Alamogordo Interagency Dispatch Center located at the western end of the expansive airport ramp area. The tour concluded with a viewing of a Neptune P-2 fire attack airplane that was undergoing some work in the large maintenance hangar toward the east end of the ramp.



Neptune P-2 fire attack aircraft sitting on the Alamogordo ramp

## ZAB CWSU Staff Continue on a Tour of New Mexico Airports

By Jim Reynolds, CWSU Meteorologist-in-Charge

On Wednesday, November 29 Tom Hall and Jim Reynolds continued on the New Mexico airports road show. In Raton, Airport Manager Keith Mangelsdorf explained that numerous wild elk are the reason for the tall game fence that surrounds the entire airport. He also discussed the number and types of aircraft operations at the airport. Because Raton is roughly equidistant from the Santa Fe, Amarillo and Colorado Springs

airports, there is a high amount of life flight traffic at the airport in order to rush patients to the various cities for higher degrees of health care. The Track fire this past summer brought numerous fire fighting air tankers to the airport for tours of duty. The Raton Airport is supported largely through the sale of fuel to transient pilots.



CWSU Forecaster Tom Hall stands in front of the Raton Airport terminal building.



The Clayton Airport terminal building

Later that day, Tom and Jim visited with Clayton Airport Manager Ed Sisneros. Though the Clayton Airport has many fewer aircraft operations throughout a given year than the Raton Airport does, the Clayton Airport is similar to that of Raton in that there is a lot of life flight traffic. However, unlike Raton that has three cities to choose from to send medical patients, many of the patients on life flights coming into Clayton end up getting directed to Amarillo. Similar to the Raton Airport, the Clayton Airport is

largely supported through the sale of fuel to transient pilots.





## First Winter Blast of the Season Arrives in Albuquerque

By Neil Haley, CWSU Forecaster

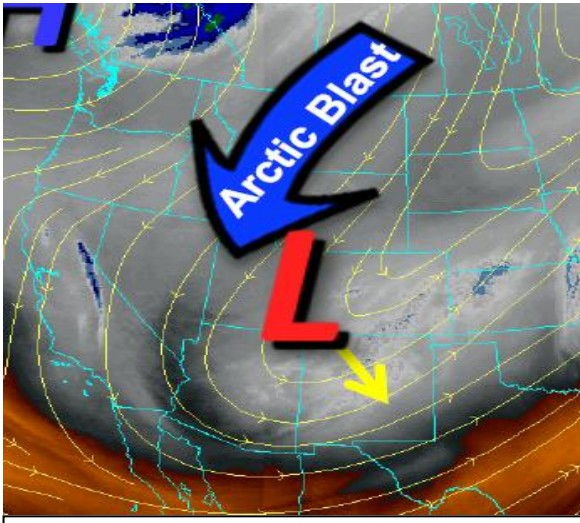
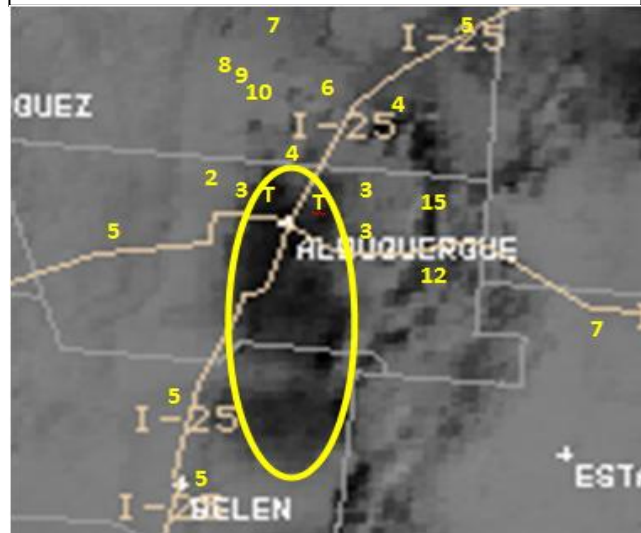


Figure 1. Water vapor image 12/5/2011

Winter slammed into New Mexico on Friday Dec. 2<sup>nd</sup> with strong winds that ushered in the coldest weather so far this season. The frigid air settled over New Mexico during the weekend and set the stage for storm two. The second storm entered the Four Corners region Sunday night Dec. 4<sup>th</sup> (Figure 1). Snow quickly developed with this system and spread throughout the state before ending Monday night Dec. 5<sup>th</sup>.

Figure 2. Visible satellite image at 19Z 12/6/2011. Skies were clear.



Snow totals varied greatly across the Albuquerque metro area. The zoomed-in visible satellite picture (Figure 2) of central New Mexico was taken Tuesday afternoon Dec. 6<sup>th</sup>. Skies were clear, so the white and lighter gray regions are areas of fresh snow. Notice the snow cover along I-25 north of Bernalillo County into Rio Rancho, Albuquerque's west side and the east slopes of the Central Mountains. Also of note, the dark area inside the yellow oval indicates a trace or no snow. This area encompasses Albuquerque's Heights extending westward to the Rio Grande River valley. The reason why the Heights, including the ZAB ARTCC, received little snow was due to the strong east winds associated with this system. The down-sloping winds descending into Albuquerque from the Sandia and Manzano Mountains dried out the atmosphere creating a "shadow effect" where very little precipitation occurred. As the east winds ascended up Albuquerque's West Mesa, the snow machine started up again. Over the last few days, I collected snowfall accumulations from several of you. These are summarized in the table below and are plotted on the map in Figure 2.

Frank TMU	Sandia Park	15"	Priscilla Admin	Tome	5"
Robbie SE	Tijeras	12"	Kim R NW Spclty	Corrales	4"
Fred Automtn	Unser/NRN	10"	Deb TMU	Corrales	4"
Bill N Spclty	Unser/NRN	9"	Ken NW Spclty	Placitas	4"
Andy SW Spclty	Unser/Rainbo	8"	Ben A Training	Paseo/Eagle	3"
Raul SOC	550/Chayote	7"	Phil S Training	Paseo/Irving	3"
Chris C Training	550/Chayote	7"	Bill OM	Tram/Ind Sch	3"
Roger CWSU	Edgewood	7"	Brian SOC	Tram/Paseo	3"
Frenchie E Spclty	528/Idalia	6"	Greg Q & A	Ventana Ranch	2"
West Mesa Radar	I-40/Lost Hrzn	5"	Jim CWSU	Acdmy/Lowell	2"
Cathy Logistics	Los Lunas	5"	Rich Airspace	Taylor Ranch	T
Melinda Traing	Algodones	5"	ZAB ARTCC		T



## ***Flight Deck Training...A Controller's Perspective***

*By Larry Braaten, Operational Manager*

ZAB has had at least 8 controllers and developmentals who have completed their Flight Deck Training. The very first flew out on September 11, 2011. One individual really took advantage of the program by flying from ABQ/DEN/ORD to JAX and on their return flight they flew JAX/IAH/Den to ABQ. This individual noted that throughout his entire flight the crew was very professional in their procedures and interactions. Some of the training objectives that they observed were:



- ✓ Monitored ATC communication throughout the flight
- ✓ Took note of how Airbus aircraft tend to start turns a bit early
- ✓ As the flight approached ORD, spacing/sequencing/metering/airport arrival constraints were evident in this flight.
- ✓ The flight was given numerous vectors and speed assignments even several hundred miles from the destination airport
- ✓ The A319 turns early like its counterpart the A320. the flight deck avionics are virtually identical with both aircraft utilizing fly by the wire controls
- ✓ Spacing/sequencing/metering airport arrival rates/constraints were not a factor in their flight
- ✓ On the second leg, the flight was vectored and assigned speeds on a few occasions
- ✓ The E45x aircraft has quite a limited space within the flight deck
- ✓ The B729 has a nice flight deck with very modern avionics and FMCS
- ✓ The flight from DEN to ABQ was delayed for approximately 1 hour and 10 minutes due to weather on the flight before
- ✓ There was nothing mentioned of having any issues due to it being 9/11/11

Others that have completed their flight deck training observed items such as:

- ✓ Altitude and route changes were confirmed and pointed at both crew members
- ✓ Expedited climb to FL380 to top storms
- ✓ Shown function and TILT capabilities of their WX Radar
- ✓ On descent into SLC they deviated to left for weather and experienced some chop
- ✓ Once they climbed above “sterile environment” headsets were removed and loudspeaker was used for ATC communications
- ✓ All 8 pilots on this trip were excellent!
- ✓ All were welcoming/knowledgeable/interactive and seemed to accept this program with open arms
- ✓ Seeing the flight planning they do and how it differs from the way we do things create an understanding that I will share with co-workers
- ✓ Observed STARS & SIDS
- ✓ Observed how the autopilot makes the majority of decisions up there as far as the speed to fly, climb descent rate all in the interest of fuel efficiency
- ✓ Didn't realize that sterile cockpit procedures existed, and found it to be very interesting

- ✓ One controller was bumped off his flight due to a CASS number mistake, but was allowed to board another flight 2 hours later
- ✓ Pilots were very busy when at FL180 and below
- ✓ Although the flight was short, these pilots had a lot of issues with controllers and a lot of concerns, i.e. why do you do this or that?
- ✓ Discussed mainly procedures while on their flight
- ✓ Was able to provide some insight into the world of ATC
- ✓ Pilots shared how they handled route and altitude changes as well as emergencies
- ✓ TCAS was explained in more details as well as ACARS
- ✓ Discussed on we can work together as a team, we had very great dialogue
- ✓ Sitting in the cockpit with the pilots has helped me to become a better controller, especially since I am more aware of what they are required to do
- ✓ On one flight once the aircraft door was shut, the pilot asked me to sit in the back
- ✓ It was my first FDT ever, Captain and 1<sup>st</sup> officer were very accommodating and answered all questions freely and usually in depth
- ✓ Operations in Class C and B airspace are virtually the same except for the chatter
- ✓ On board wx radar is limited in what it can paint, pilots noted that they generally wait until 30-40 miles out to come up with a concrete action plan
- ✓ There is a checklist for every phase of flight (preflight, pushback, engine start, taxi, pre-takeoff, climb, cruise, pre-descent, descent, final, rollout, arrival at the gate)
- ✓ Two things really stood out: 1) the workload is amazingly light during routine flights with no wx, the automation is fantastic and 2) the pilots are usually unaware of restricted airspace around them unless they pull out a chart or are advised by ATC
- ✓ Upon entering the flight deck, there was confusion on what role I played in the FAA, once pilots found out I was a controller they became more at ease
- ✓ Observed that the pilots were very diligent in listening to their radios at all time except when they were at altitude
- ✓ The equipment the pilots used seemed to be adequate, they still use flip charts, they said they are due to receive iPads with all the information they need in the near future
- ✓ We discussed the RNAV arrivals and profile descents
- ✓ We also discussed aircraft limitations and optimal altitudes for fuel conservation
- ✓ Strong winds made for an interesting landing
- ✓ Pilot was thrilled to see ATC back in the cockpit
- ✓ Veteran pilots were very experienced
- ✓ We flew in an MD90, pilots stated that the MD90 are not preferred being that the equipment is not standardized
- ✓ We were capped at FL 250, due to an air conditioning component being OTS
- ✓ Due to the above we had no choice but to fly through some ugly clouds, which produced moderate turbulence
- ✓ Not once during the flight did the pilots miss a call or have a re-back error
- ✓ Pilots reviewed their checklists several times, not overlooking anything
- ✓ ACARS equipment was outdated, it looked like an old PC, just not that big
- ✓ Listened and learned from their point of view on traffic and arrivals
- ✓ Traffic calls can be annoying as one person gave them traffic that was 35 miles away
- ✓ Shortcuts when they are in close vicinity to the airport is not always accommodating because now they have to readjust everything.



## ***February is National African American History Month – Honoring the Tuskegee Airmen***

*By Jim Reynolds, CWSU Meteorologist-in-Charge*

While it is commendable that we designate individual months to recognize certain races of people or those of a particular heritage, I think it often happens where those people outside of a recognized race or heritage miss the point of the recognition because it is so general. To counter that, I would like to point out the contributions of some specific people during National African American History month. Because you work at ZAB, you most likely share the passion for aviation that I do. When combining National African American History month with our passion for aviation, I cannot think of a better way to be more specific about the contributions of African Americans to this country than to talk about the Tuskegee Airmen.

Now we've all heard about the Tuskegee Airmen, but do you really know what they accomplished in America's effort during World War II? For some background, the Tuskegee Airmen officially resided within the 332<sup>nd</sup> Fighter Group and the 477<sup>th</sup> Bombardment Group of the U.S. Army Air Corps. Before the establishment of these groups, no African American had ever become a U.S. military pilot. Although the 477<sup>th</sup> Bombardment Group trained in B-25 Mitchell bombers, this group never flew any missions in combat. The most noteworthy accomplishments of the Tuskegee Airmen are derived from the 332<sup>nd</sup> Fighter Group. Initially, this group learned to fly Curtiss P-40 Warhawk fighter-bomber aircraft and Republic P-47 Thunderbolts. However, it was their work with North American P-51 Mustangs that built the 332<sup>nd</sup> Fighter Group's impressive reputation. The Fighter Group may be more famously known as the "Red Tails" because the pilots of the 332<sup>nd</sup> painted their airplane tails crimson red.

In all, 996 pilots were trained in Tuskegee from 1941 to 1946. The Tuskegee Airmen were officially credited with the following accomplishments:

- 15,533 combat sorties, 1,578 missions
- 112 German aircraft destroyed in the air and another 150 on the ground
- 950 railcars, trucks and other motor vehicles destroyed
- 1 Destroyer sunk by P-47 machine gun fire
- A good record of protecting U.S. bombers with only 25 lost during hundreds of missions.



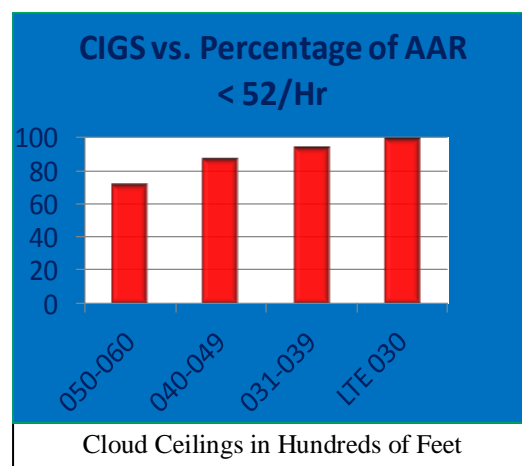
*Tuskegee Airmen (photo courtesy of The Black Archives - Kansas City, Mo)*

## ***ZAB CWSU Study of Winter-time Low Cloud Ceilings at KPHX***

*By Roger Smith, CWSU Forecaster*

During the summer of 2011, Neil Haley and I began a study of low cloud ceilings associated with reduced AAR's (Airport Arrival Rates) at KPHX (Phoenix Sky Harbor International Airport) during the period from October through March. One of the major motivations for this research were questions asked by the TMU (Traffic Management Unit) at the standup briefings regarding whether or not the ceiling at KPHX would fall below 6000 feet, and, if so, what would be the onset time and duration of these lower ceilings. One of the goals of this study is to identify the types of storm systems which produce these conditions. Through an analysis of the weather patterns which create these storms, we hope to achieve marked improvement in the forecasts of low cloud ceiling events at KPHX. The forecasting goal will be to use the results of this study to give the ZAB staff greater advance warning for these events at standup briefings and through the issuance of the MIS's (Meteorological Impact Statements).

The first part of this study involved an examination of the effects of different cloud ceiling categories on AAR's at KPHX. Hourly and special weather observations for KPHX from October through March for 2003 through 2010 were inspected for cloud ceilings below 6000 feet from a METAR data set acquired from NCDC (National Climatic Data Center). With the time periods for lower ceilings identified, we needed to determine what the AAR's were during these hours. AAR's from the TMU log shifts were then correlated with the times of lower cloud ceilings. Neil and I would like to thank the TMU staff for graciously allowing us access to the shift logs this past summer and fall. Although there are other meteorological factors which could affect AAR's at KPHX, such as slant-wise visibility and cloud decks in the vicinity of KPHX, a relationship between cloud ceilings at KPHX and AAR's could still be useful in categorizing ceiling heights coincident with lower AAR's at KPHX. 703 hours of data was examined and yielded some interesting results. Below is a graph exhibiting cloud ceiling categories in hundreds of feet displayed on the horizontal axis and the percentage of hours with AAR's below 52/hour displayed on the vertical axis.

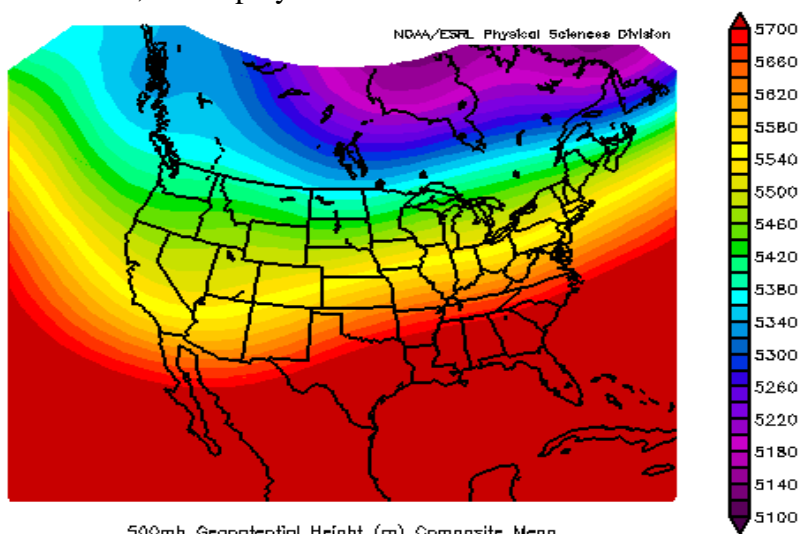


As seen above, cloud ceilings between 5000 and 6000 feet were correlated with airport arrival rates less than 52/hour 71.8% of the time, 4000-4900 foot ceilings 87.2% of the time, 3100-3900 foot ceilings 94.4% of the time and 100-3000 foot ceilings 98.7 % of the time.

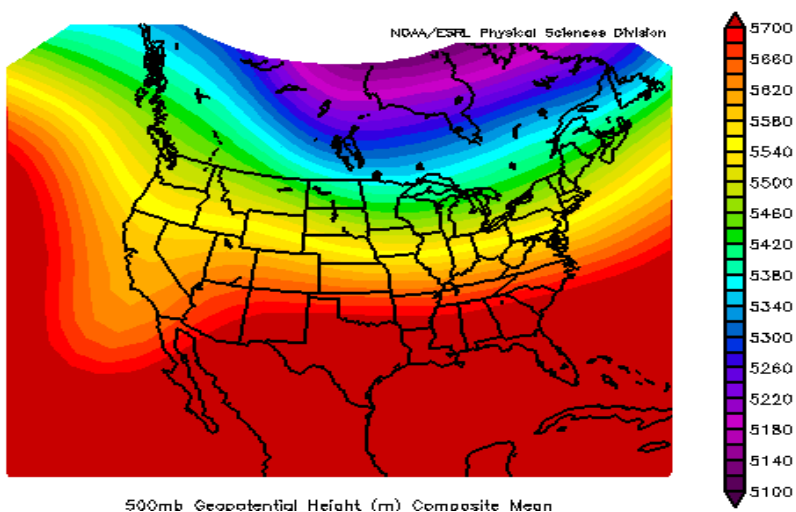
With a useful relationship established between cloud ceiling categories and arrival rates at KPHX, METAR data for KPHX was examined from 1986 to 2010 to catalogue storms which produced these various ceiling categories. There were 421 storms in this 25-year period which produced one or more of the ceiling categories for a period of 3 hours or greater. In cases where multiple ceiling categories occurred, we categorized the storm based on the lowest ceiling category observed for 3 or more hours. The breakdown of these storms is as follows: 94 storms with ceilings less than or equal to 3000 feet (22.3%), 53 with ceilings ranging from 3100 to 3900 feet (12.6%), 117 with ceilings ranging from 4000 to 4900 feet (27.8%) and 157 with ceilings ranging from 5000 to 6000 feet (37.3%).



We will examine the storm types and the weather patterns associated with each of these categories over the next 6 months. A preliminary study of the most impactful storms, those with ceilings less than or equal to 3000 feet for a duration of 10 hours or greater at KPHX, was conducted earlier this fall. A poster displaying the findings was presented at the Southwest Aviation Safety Workshop held on October 25<sup>th</sup> and 26<sup>th</sup> in Albuquerque. Four types of storms producing this lowest-ceiling, long-duration category were identified: The Western U.S. Trough, the Southern Stream Closed Low, The Northern Stream Closed Low and the Southern Stream Progressive Trough. The composite weather patterns at roughly 18,000 Feet MSL for two of the storm categories, derived from multiple storm events from 1986 to 2010, are displayed below:



Western U.S. Trough (at event onset)



Southern Stream Closed Low (at event onset)

By analyzing the weather patterns 24, 48 and 72 hours prior to the onset these events, it is our goal to gain a better understanding of the evolution of the weather patterns which lead to these impactful events. This knowledge should enable us to predict these events with greater accuracy and lead time, providing better service to the ZAB staff.